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Integrated Assessment of forest bioenergy systems in Mediterranean basin areas: The case of Catalonia and the use of participatory IA-focus groups

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Abstract

The present paper applies and adapts the methodology of integrated assessment focus groups (IA-FGs) in order to understand and analyse the enhancing factors, as well as the constraints which drive or limit the take-off and development of sustainable forest biomass energy systems in a selected large forested area of the Mediterranean basin. Our study provides both quantitative and qualitative data from Catalonia, Northeast Spain. We provide historical trends in forest expansion; an assessment of technological, socio-economic and ecological options of forest management; and plausible scenarios of its future evolution. Results show that while the opportunities and stakes are high, in Mediterranean countries, specific socio-ecologic factors need to be taken into account if forest biomass is to contribute decisively to securing renewable sources of energy in Europe, integrating landscape planning with resource policies or mitigating climate change. Among these key factors identified are property regimes, low productivity of Mediterranean forests and weak institutional capacity. Other elements such as logistics and supply difficulties and the lack of economic profitability of forest products constitute limitations identified in the implementation of bioenergy systems. Technological solutions alone, while important, are insufficient to ensure

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a prominent role of Southern Europe forest biomass management in the climate, landscape and sustainability energy policy challenge.

Keywords: Integrated assessment focus groups; Decision-making; Bioenergy systems; Forestry biomass; Sustainability

Contents

1. Introduction

Biomass has the potential to become one of the major renewable primary energy sources, and forest biomass in particular has an important role to play in the landscape management and in the climate policy domain during the present century. Integrated bioenergy systems are suggested to be important contributors to ensure future supply of energy and to provide an array of diverse sustainable development services both in industrialized countries as well as in developing countries [1,2]. Bioenergy can be of great significance in mitigating climate change by reducing carbon dioxide (CO_2) emissions and by a progressive replacement of fossil fuels in the transition towards sustainable energy futures. According to the Kyoto protocol, the EU is to reduce greenhouse gas emissions by 8% from the level of 1990 [3] by the period years of 2008–2012. Furthermore, the EU's commitment in the share of renewables is to meet the 12% of gross energy consumption by 2010 [4]. Under these circumstances, alternative sources of low-carbon intensity energy are being explored. The Biomass Action Plan was designed to increase the use of bioenergy in order to achieve the EU's targets, which aims to increase the use of biomass energy in the heating, electricity and transport sectors from 69 million tons of oil equivalent (Mtoe) in 2003 to around 150 Mtoe in 2010 [5]. However, recent assessments have concluded that the targets will not be met without taking strong and specific measures. Under these circumstances, alternative sources of low-carbon intensity energy are being explored.

Among them, the forestry biomass sector is also being regarded as an important sector capable to contribute to the fulfilment of the Kyoto commitments. Forest biomass production and management, besides being able to be used as a source of primary energy with lower CO_2 emissions than fossil fuels for some specific applications, can also be used as part of the Kyoto flexibility mechanisms, thanks to its potential role within the development of the emission tradable permits and sinks creation. The European Climate Change Programme includes policies and measures in energy supply, as the promotion of electricity produced from renewable energy resources (Directives 2001/77/EC) with an indicative target of 21% in the share of EU gross electricity consumption to be reached by 2010 [6]. However, the state of development of the wood energy sector is far from homogenous across the EU member states [7–11]. Drivers and barriers behind the development of the bioenergy market have been investigated, although they mainly focused on northern countries [12]. In northern European countries, energy production systems are well developed and studied. In contrast, they are not widely established in Mediterranean regions, where geographical and climatic characteristics limit in particular the forestry biomass harvesting, due to the low forest productivity and precipitation [13,14]. In Spain, many policies were settled to achieve European targets in terms of energy production. The National Action Plan for Renewable Energy Sources increased bioenergy targets in order to achieve the 12% of gross consumption from renewable sources [15]. Despite these targets, the developments in the sector are slower than had originally been anticipated. On the other hand, the risks of forest fires have increased due to a number of reasons, including the growth of biomass accumulation and the overgrown forest floor vegetation as a result of abandonment of some traditional activities and the lack of forest management [16–18].

1.1. Context and objectives of our study

Our study focuses on the case of Catalonia, a region located in the northeast of Spain, where the wooded forestry area takes up 12,146 km^2 (the 38% of Catalonia) and represents the 10% of the Spanish forestry area [19–21]. A 26% increase of the wooded forestry area is accounted between the years 1945 and 1990 and it is expected to have risen during the last decades, due to the overgrowth of forestry area at the expense of cultivated areas [18]. A wide definition of forestry area which includes also meadows and scrublands takes 61% of the area of Catalonia. Four main tree species occupy two-third parts over the whole forestry territory: *Quercus ilex*, *Pinus sylvestris*, *Pinus halepensis* and *Pinus nigra* [19]. The forest fires affect periodically the Catalan forests and are characterized by their high temporal and spatial irregularity [22]. At present, the deployment of an important institutional and technological capacity to combat forest fires has also lead to a further growth of forests' extension (see Fig. 1) and biomass accumulation in detriment of intermediate open spaces and buffer zones which are also crucial in performing a number of ecological and socio-economic functions such as biodiversity conservation.

Therefore, it is necessary to analyse specifically which factors impede or can enhance the take-off and development of sustainable and socially integrated energy systems based on the adequate management, exploitation and conservation of forest management resources in the Mediterranean basin countries, such as our case study area of Catalonia.

While the opportunities for the sustainable use of such biomass potential and the prevention of risks are high, the constraints seem to be of multiple and complex nature.

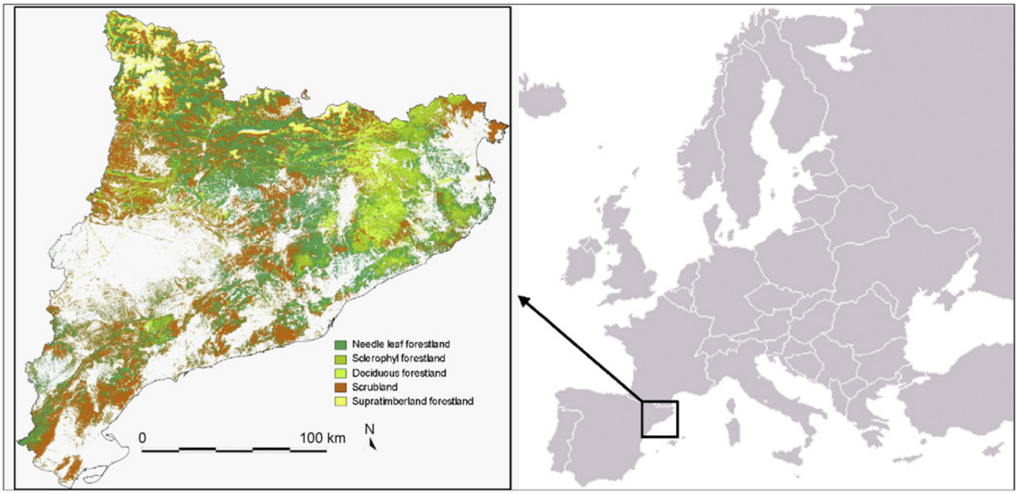


Fig. 1. Forestland of Catalonia composed of needle leaf forestland, sclerophyl forestland, deciduous forestland, scrubland and supratimberline forestland.

Our paper looks at the factors which could make forest biomass commercially viable as well as could enhance the biodiversity and social equity potentials of those areas. We are interested in identifying what political, social and environmental barriers have prevented integrated forest bioenergy systems to be further developed in a Mediterranean context such as Catalonia. We aim at meeting this goal by complementing the analysis of quantitative historical and update information on evolution of forest biomass in this area, analysing alternative technologies and options of exploitations and by the use of a participatory integrated assessment (IA) methodology. In particular we use and adapt to our case the integrated assessment focus groups (IA-FGs) method as described in Kasemir et al. [23].

2. Methodology: IA-FGs

The group discussion procedure that inspired our research is part of the growing research field of participatory IA [24] and also of the emerging field of integrated sustainability assessment (ISA) [25,26]. IA aims to gather, structure, synthesize and present interdisciplinary knowledge in order to inform in a relevant manner policy decision on complex issues. IA can be understood as those conscious, interactive and interdisciplinary and social practices occurring at the intersection between the three domains of public communication and debate, political decision and evaluation. Within IA, these three domains are intimately interrelated, as appropriate communication is essential for an adequate decision making and assessment, and in turn, all these dimensions can only be integrated via enhanced public participation and mutual social learning [27]. Usually, environmental IA is carried by an iterative process of three main stages: (i) problem structuring, (ii) problem analysis, and (iii) communicating the results and assessment directly or indirectly to the users of the evaluations [28]. Also, it is assumed that scientists can learn from the society, which plays a crucial role in the co-production of relevant

knowledge and, hence, integrating the public constitutes an important movement to the democratization of the science and its applications.

In IA-FGs, expert information from a variety of sources, such as computer models, are used to support group conversations among a diversity of stakeholders, including non-experts publics. The participatory techniques used in our research adapted and shortened the procedure discussed by Kasemir et al. A typical IA-focus group can be designed along the following lines: a group consists of approximately six to eight citizens, sampled according to a pre-established recruitment criteria yielding a broad heterogeneous mix of participants, including different attitudes towards the environment. These groups meet for three to five sessions of about 2.5 h each. A moderator facilitates the discussions of the participants on the issues at stake and both quantitative and qualitative statements are gathered to obtain narrative assessments on causes–effects of specific policy-related processes as well as the possible options and pathways to deal with their future evolution. Participants have access to expert sources of information, including experts themselves and usually the group is complemented with a note taker and several audio or video means to record the conversations. Other visual forms and analytical tools can be used, such as participative scenarios, to enrich the IA process. In our case, our meeting only lasted 1 day and did not use computer models, although other expert knowledge was provided to the stakeholders beforehand. The focus of the participatory exercise was mostly to devise participatory scenarios on driving forces and hindrances which condition the future of biomass forest energy systems development in Catalonia.

IA-FGs also depart from the assumption that group discussions produce a different kind of results—richer, more reflective and collective, and potentially more policy relevant—than those obtained simply through the aggregation of individual preferences, such as it is the case with quantitative opinion polls. IA-FGs intend to increase the opportunities to obtain not only (superficial) 'opinions' but more distinctively in-depth *reflections* on collective matters. Participatory IA processes serve different purposes and functions, and very often most of them are carried out at the same time [16]. Specifically they can help to:

(a) *Better framing* by defining in more relevant ways the problems at stake, their possible causes, effects, and feasible courses of action or even futures on the basis of the stakeholders' views. By doing so, there is less likelihood for the wrong formulation of the problems and for adopting false underlying research and policy assumptions, out of which only wrong answers can emerge.
(b) *Improve efficiency and equity* by enhancing the efficiency of the available information, communication and participation channels both for the production of knowledge and for feeding the policy-making process with preferences and views which would rarely be taken into account otherwise. And by doing so, they can contribute to increase the potential to yield more effective and equitable assessments and decisions on complex issues, especially when large number of uncertainties are present.
(c) *Enhance the integration* of diverse knowledge and value domains, both from experts and non-experts sources, as well as from different scientific disciplines. In this way, participatory IA procedures can improve the diversity and representativeness of the knowledge used in decision making, being those criteria fundamental in the new emerging sustainability assessment.
(d) *Contribute to social learning* by optimizing the existing processes of social and institutional learning, by rising awareness of complexities and uncertainties of the

situation, as well as the limits or the gaps in the available knowledge and of the capacities to deal with them. And in doing so, they can become central in all mutual and social learning processes occurring between policy makers, experts and the general public or relevant stakeholders.

We understand that group discussions such as those carried out in our research can help a better framing support of policy making, since they can integrate the knowledge of all the society sectors and continuous process of social learning, rather than holding science as something external and above it [29].

The IA methodology can typically be structured in a cycle of three stages: (i) inputs; (ii) integration and participation; and (iii) outputs.

(i) *Input stage* consists of all the information that is required to be used as a preparation for the meetings (research questions, variables to analyse, news, etc.).
(ii) *Integration and participation stage* is when the focus group meeting is being held (collective discussion of the research questions, participatory analysis of the scenarios, etc.).
(iii) *Output stage* consists of the information that results from the meetings (new knowledge, new scenarios proposals, preference policies, new actors–grids, etc.).

3. Process and results

To analyse the viability of the implementation of forest bioenergy systems in Catalonia, the IA methodology by means of public participation process was applied. This participation process is started by the organization of two focus groups [23], where different actors from different fields are brought together. These two meetings allowed identifying the major gaps for which forest bioenergy systems have not been implemented in Catalonia. The participatory techniques used in our research adapted and shortened the procedure discussed by Kasemir et al. Two focus groups were organized in March and April of 2005 in order to analyse the critical points of the applications of bioenergy systems in Catalonia. The participants came from different fields but they were eager to explore the topics explained and introduced [30]. The topic introduced must be appropriated for the participants, in order to generate a free-flowing and productive conversation on the topic. That setting was also complemented with a series of previous interviews with relevant stakeholders to identify the key issues at stake as well as the main agents to be invited [31].

A total of 23 people participated in the focus groups and they were from the: policy field (local and national government); science and expert knowledge (researchers from different universities and institutes, technicians from local governments and businessmen of forestry business); and non-academic knowledge (forestry owners, non-governmental organizations and ecologists; interested businessmen, who were interested in the implementation of these systems in their sectors (i.e. a concrete factory interested in the reduction of CO_2 emissions)) (see Fig. 2).

3.1. Development of the IA-FGs

Before the focus groups sessions, a work document was sent to the different participants, where the session structure and the questions to be discussed were presented. Three main

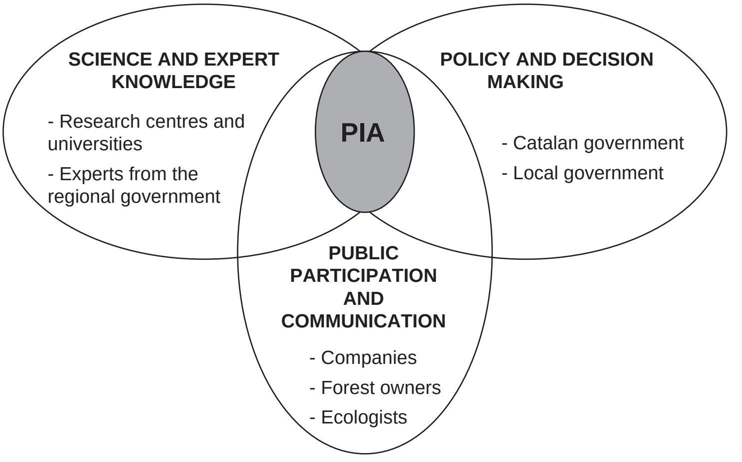


Fig. 2. Participatory integrated assessment (PIA) as the intersection of the three domains of knowledge, decision making and public participation and communication, and the participants of the focus groups.

Table 1
Key questions introduced to the focus group

Key questions
(1) Is the characterization of the forestry biomass problem appropriated?
(2) Which are the most probable environmental and social consequences of not taking part in the nowadays dynamic?
(3) What is the role of the security of the biomass supplier in the evolution of the present scenario? Which practices are needed in terms of the different agents in order to assure the forestry biomass supply?
(4) What are the possible impacts of the forestry biomass used in the present wood market?
(5) How should the new wood market be planned?
(6) What should the role of the government, as a forestry owner, be?

parts were differentiated in the document: (1) presentation and objectives of the meeting, (2) the problem characterization, and (3) a preliminary proposal of the scenarios to discuss.

Problem definition requires a clear statement of what kinds of information are desirable and from whom this information should be obtained. A clear understanding of the problem, or general research question, is critical because it gives rise to the specific questions that should be raised by the moderator, and identifies the population of interest [32]. The characterization of the problem consisted of the context of the forest bioenergy use in order to facilitate the discussion. The text described the economic infeasibility of the forest exploitation which results in an extra-accumulation of biomass during the last decades. There are two principal motivations in order to influence this tendency: the fire risk and the Kyoto protocol coming into effect to decrease the greenhouse gases, and the creation of an emission market. Also six key questions were depicted to start the discussion (see Table 1).

To give appropriate information to group participants, the Catalan background presented was mainly related to two fields: state of bioenergy in Catalonia and biomass potential in Catalonia.

3.1.1. Bioenergy in Catalonia

Many policies are settled in Catalonia referring to bioenergy, as the Catalan Energy Plan 2006–2015 which estimates an increasing forest and agricultural biomass consumption of 197% within this period of time (279 ktoe). This biomass consumption is mainly dedicated to heating options for household use and industrial use, such as sawmill industries. There are few bioenergy plants working, all with a maximum power of 5 MW, which operate with agricultural residues mostly.

3.1.2. Biomass potential in Catalonia

To know the availability of the bioenergy systems implantation in Catalonia, the biomass potential in Catalonia was estimated. Moreover, not only the potential of forest residues was calculated but also the potential of agricultural, sawmill industries and bulky wastes. Considering all these types of biomass, the Catalan biomass potential is about 2.6 millions of tones of dry matter, which represents approximately 1 Mtoe (see Table 2).

Three scenarios were defined to discuss during the session, and many variables were defined to analyse the scenarios (see Table 3).

The first few moments during the focus group consisted of welcoming the assistants. Afterwards, a general overview of the topic was given, explaining the objectives of the sessions. Guidelines and ground rules of the interaction between stakeholders were also explained in order to set strategies and encourage good discussions. Finally, an opening question was introduced to get each participant to talk.

Every focus group session longed approximately 3 h, and was organized in the following parts:

(1) *Presentation and discussion of the key questions*: After the focus group presentations and the participant presentations, open discussion was realized about the bioenergetics forestry use in Catalonia. Each participant had 5 min at maximum to express his/her point of view in a general fashion. This part lasted 1 h.

Table 2
Biomass potential estimated in Catalonia (1919) [33–35]

	Quantity (kton)	LHV (toe/ton)	Energy (ktoe)	Percentage (%)
Forest				23.8
Arboreous area	323	0.42	136	12.3
Shrub area and dead trees	300	0.42	126	11.4
Industry				2.83
Industry and manufacturing	100	0.42	42	3.8
Agriculture				68.1
Herbaceous crops	1500	0.40	603	57.2
Woody crops	285	0.43	123	10.9
Bulky wastes				4.4
Furniture	71	0.42	30	2.7
Pruning and gardening	44	0.37	16	1.7
Total	2623		1076	

Table 3
Scenarios and variables defined to discuss during the focus group session

Scenarios
Scenario 1: Small plant (from 1 to 500 KW of power), to install into public equipments such as schools, sports centre to produce heat and to install houses, public equipments, etc.
Scenario 2: Medium plant (from 0.5 to 2 MW of power), to produce heat for district heating
Scenario 3: Cogeneration plant (from 5 MW of power), to produce heat and electricity
Variables
(1) *Environmental variables*: difficulty in the wastes management, impact of the emissions of the plant and the transport, infrastructure impact and global warming impact
(2) *Economic and technological variables*: economic profitability, synergic possibility of other economic activities, energy efficiency, plan requirements in the fuel shape, and the effect of the forestry fires in the supplier guarantee
(3) *Social and policy variables*: benefits for the local economy, creation of employment, possibility to use synergies in the urban planning, impact of the forestry owner's fragmentation and the supplier business, and importance to communicate and inform society about the implementation process and exploitation of the plants

(2) *Scenarios group discussion*: During the work session, comparative analysis of the technological, economic, political, social and environmental variables was performed for the three scenarios. The assessment of these variables for each scenario followed a punctuation of quite positive, not so positive, neutral, very negative, quite negative and not so negative. This session also lasted an hour.
(3) *Conclusions and process evaluation*: After a small break, the conclusions of the session and evaluation of the process was carried out. In this part, the participants not only could express their feelings about the bioenergy systems implementation, but their opinions about the focus group organization and performance.

3.2. Focus groups results

After interpreting the qualitative data obtained during the focus group sessions, the results fell into four categories: (i) biomass situation analysis in Catalonia; (ii) policy recommendations to the Catalan forestry sector; (iii) aspects to be considered in a bioenergy system implementation in Catalonia; and (iv) scenario analysis.

3.2.1. Biomass situation analysis in Catalonia

Some cause–effect relations were devised that helped to explain the existing situation of the forestry biomass in Catalonia (see Fig. 3).

3.2.2. Policy recommendations to the Catalan forestry sector

The main actions to be taken in order to solve the present problems of the Catalan forestry sector according to the focus groups were:

(1) consensus and effective forestry planning between all people involved (forestry owners, businessmen, researchers, users, etc.);

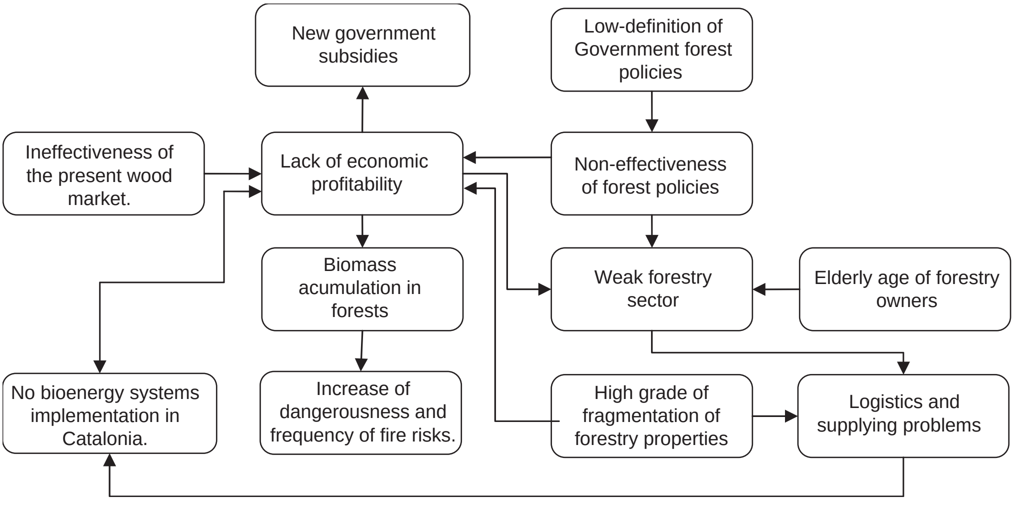


Fig. 3. Cause–effect diagram of the relationship of the forestry biomass sector in Catalonia devised in the focus groups.

(2) fire preventative action by means of forestry cleaning and a related forestry policy; and
(3) creation of a real wood market capable to incorporate all real needs and expectations of the forestry products developed in Catalonia.

3.2.3. Aspects to be considered in a bioenergy system implementation in Catalonia

According to the focus group, many general aspects have to be considered in a bioenergy system implementation. The first thing that has to be regarded is its complementariness with other renewable energies, since forestry biomass cannot only easily interact and complement them but the forestry biomass contribution to produce neutral CO_2 emissions depend on this interaction. However, harvesting, transportation and waste management emissions should be taken into account, as the soil carbon fixation.

An adaptation of forest management strategies is necessary and binding them to the territory, since the forestry area in Catalonia is characterized by its heterogeneity, both in an environmental and social way. Its diversity means that for a determinate area there are capabilities that are possible to be developed, but they may completely differ from other areas. The social actors and the natural territory characteristics are those that determine which is the model and the option more adequate. It is also important to adapt the type of the energy production (heat, electricity) to the particular demand of that territory.

The results of this analysis are divided into environmental, economic and technological, and social and policy aspects (see Table 4).

3.2.4. Scenario analysis

The three scenarios were analysed on the basis of their complementarity and relevance. The results of this analysis are also divided into environmental, economic, technological, social and policy aspects (see Table 5).

Table 4
Key aspects to be considered in the economic, technological and environmental fields, according to the focus group

Fields	Key aspects
Economic	• To allow forest bioenergy systems with the present wood market • To define and regulate which biomass is viable to use • To generate a forestry market for bioenergy systems • The market regulation has to be intervened by the administration • To limit transportation distance up to 50 km
Technological	• Projects should be possible at short term (combustion processes) • To adapt harvesting machinery to Mediterranean forests • To standardize and normalize the fuel shape before its commercialization • To assure the electricity evacuation in the electric grids
Environmental	• To define sustainable forest harvesting • To control combustion emissions • To maintain the landscape mosaic • To consider other possibilities as energy crops
Social	• Logistic and supplier problems • To manage adequately possible bad social perception of bioenergy systems in the beginning

Table 5
Key aspects to be considered for the scenarios analysis, according to the focus group

Scenarios	Key aspects
Environmental	• Difficulty of the waste management • Transport and combustion emissions • Infrastructure impacts • Contribution to global warming
Economic and technological	• Economic profitability in short term in small and medium plants • Competence in the wood market • Plan requirements about biofuel standards (size, humidity and LHV[a]) • Forest fires affect more the small and medium plants, for the biomass supplying and dependence
Social and policy	• Positive indirect impacts, as territory development • Direct benefits are bigger in a big plant • Employment creation depends on the size plant • Difficulty to find qualified workers for working in forest areas • Positive synergies with the urban planning • Importance to communicate and inform the citizenship

[a]LHV: lower heating value (also known as *net calorific value*).

4. Conclusion

This paper presents the results of a participatory experience to understand the driving forces that guide the implementation of forest bioenergy systems, which are not widely

introduced in the Mediterranean basin, although there is the need of incorporating renewable sources in the energy sector and a sustainable forest and landscape management. Generally, it is considered that the implementation of the forest bioenergy systems in Catalonia is a process soon to be developed and put into practice, not only for the global necessities of energy diversification, foster new sources of renewable energies and the decrease of forest fires risk but also for the high interest aroused in a great part of the society. Besides, forestry biomass plays a fundamental role as energy source in climate change, due to its capacity to fix CO_2, which helps to mitigate the global warming effect. The main research findings drawn from focus groups are that the bioenergy sector in Catalonia is characterized mainly by a lack of economic profitability of forestry products, logistics and supply problems, and biomass accumulation in forests which derivate to a dangerousness and fire risk. There is also a lack of a real forestry market; a high fragmentation of forestry properties along with the conservative owners' character; and a lack of a well-defined forestry policy. The scenarios analysis also demonstrated that the scenarios definition was insufficient, since it was mainly based on technology aspects; and that the positive and negative impacts seemed to be quite dependent on the government regulation and control.

On the whole, IA methodology, such as the one developed in this paper, is regarded as a good approach to face up to sustainability problems, which involve a large number of issues intimately interrelated, associated to social structure, culture, political and economic aspects. Furthermore, it facilitates to implement and continue different processes of public participation and decision making, helping to meet all the actors involved in the process, and thus create a discussion forum which gathers the relevant views that need to be considered in the implantation of these new energy sources. With this methodology, it is possible to make a step forward to a global and integral knowledge of sustainability.

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